TITLE OF THE INVENTION

Piston Type Compressor

BACKGROUND OF THE INVENTION

The present invention relates to a piston type compressor. Specifically, the present invention pertains to a piston type compressor that has a structure for bypassing residual gas remaining in a compression chamber of high pressure after discharging gas to a compression chamber of low pressure.

A piston type compressor disclosed in, for example, Japanese Laid-Open Patent Publication No. 6-117366 has a compression mechanism, which has a plurality of cylinders, and a suction valve unit. As a rotary shaft rotates, pistons disposed in the respective cylinders reciprocate. The reciprocal motion of the pistons draws gas into a compression chamber defined in each cylinder from a suction pressure zone via the suction valve unit. The drawn gas is then compressed in the compression chamber and subsequently discharged from the compression chamber. A communicating passage extends from each compression chamber. The suction valve unit has a suction guide hole that sequentially connects communicating passages to the suction pressure zone in the suction stroke as the suction valve unit rotates in synchronism with the rotary shaft.

Figs. 6(a) and 6(b) show a rotary valve 100 as a suction valve unit equipped in the piston type compressor disclosed in the aforementioned publication. In Figs. 6(a) and 6(b), the rotary motion of the rotary valve 100 is developed and expressed as a linear motion. Also, the rotation of the rotary shaft about the axis is transformed into the leftward

movement (see Fig. 6(b)). A plurality of introducing passages 101 are provided between the individual cylinders and the outer surface 100a of the rotary valve 100. Each introducing passage 101 has an opening 104 facing the outer surface 100a of the rotary valve 100. A residual gas bypass groove 103 is formed on the outer surface 100a of the rotary valve 100. The residual gas bypass groove 103 connects a high pressure introducing passage 101A among the introducing passages 101, which communicates with the high pressure compression chamber after the discharge stroke ends, to a low pressure introducing passage 101B, which communicates with the low pressure compression chamber.

The gas remaining undischarged (residual gas) in each compression chamber after the discharge stroke ends is sent to the low pressure compression chamber via the high pressure introducing passage 101A, the residual gas bypass groove 103 and the low pressure introducing passage 101B. Accordingly, the reexpansion of the residual gas in the suction stroke of a compression chamber becomes smaller, making it possible to surely suck the gas in the suction pressure zone into the compression chamber. This can improve the volumetric efficiency of the piston type compressor.

As indicated by the two-dot chain lines in Figs. 6(a) and 6(b), the peripheral portion 106 of the opening 104 has curved portions 106a curved other than radially outward of the rotary valve 100 for the sake of convenience of processing the high pressure and low pressure introducing passages 101A and 101B and increasing the strengths thereof, and some other reasons.

In a part of each curved portion 106a that is closer to the residual gas bypass groove 103, an approximately right quarter circle portion in Figs. 6(a) and 6(b) or an advancing area 106a-1 is equivalent to an inclined portion extending in

the circumferential direction (lateral direction in the diagrams) and the axial direction (vertical direction in the diagrams) of the rotary valve 100. In the same curved portion 106a, an approximately left quarter circle portion in the diagrams or a trailing area 106a-2 is also equivalent to an inclined portion extending in the circumferential direction and the axial direction of the rotary valve 100.

Two openings that communicate with the individual introducing passages 101 and the opening 104 are formed in the residual gas bypass groove 103. Each opening has a constant width extending in the axial direction. Of the two openings, a high pressure opening 103a located closer to the high pressure introducing passage 101A has a peripheral portion 105 whose advancing area 105a and trailing area 105b are formed straight extending in the axial direction of the rotary valve 100.

As shown in Fig. 6(a), at the time the communication of the high pressure opening 103a with the opening 104 of the high pressure introducing passage 101A starts, the advancing area 105a of the peripheral portion 105 of the high pressure opening 103a overlaps a advancing area 106b-1 of a linear portion 106b of the peripheral portion 106 of the high pressure introducing passage 101A. In this state, the lower in the diagram downward the advancing area 105a of the peripheral portion 105 of the high pressure opening 103a is, the longer the distance from the advancing area 106a-1 of the curved portion 106a of the peripheral portion 106 of the high pressure introducing passage 101A becomes.

As indicated by the two-dot chain line in Fig. 6(a), even when the communication of the high pressure opening 103a with the opening 104 of the high pressure introducing passage 101A starts, it takes time for the advancing area 105a of the

peripheral portion 105 of the high pressure opening 103a to significantly come inside the advancing area 106a-1 of the curved portion 106a. As a result, the opening area (overlapping area) of the high pressure opening 103a with respect to the opening 104 of the high pressure introducing passage 101A increases gently.

As shown in Fig. 6(b), at the time the communication of the high pressure opening 103a with the opening 104 of the high pressure introducing passage 101A ends, the trailing area 105b of the peripheral portion 105 of the high pressure opening 103a overlaps a trailing area 106b-2 of the linear portion 106b of the peripheral portion 106 of the high pressure introducing passage 101A. In this state, the trailing area 105b of the peripheral portion 105 of the high pressure opening 103a has already passed the trailing area 106a-2 of the curved portion 106a in the peripheral portion 106 of the high pressure introducing passage 101A. That is, as indicated by the two-dot chain line in Fig. 6(b), the opening area of the high pressure opening 103a with respect to the opening 104 of the high pressure introducing passage 101A is greatly reduced a long time before the communication of the high pressure opening 103a with the opening 104 of the high pressure introducing passage 101A ends.

To reliably send the residual gas remaining in a compression chamber of high pressure after discharging gas to a compression chamber of low pressure, therefore, it is necessary to make the width of the high pressure opening 103a of the residual gas bypass groove 103 wider, that is, set the rotation angle of the rotary valve 100 larger during the period from the beginning of the communication of the opening 103a with the opening 104 of the introducing passage 101 till the end of the communication.

To set the width of the high pressure opening 103a wider, the advancing area 105a of the peripheral portion 105 of the high pressure opening 103a may be positioned farther away from an opening 107a of a suction guide hole 107. In this case, however, the timing at which communication of the high pressure opening 103a with the opening 104 of the introducing passage 101 starts is advanced, leading to early bypassing and recompression of the dischargeable gas. In the case where the width of the high pressure opening 103a is set wider, therefore, the trailing area 105b of the peripheral portion 105 should be positioned closer to the opening 107a of the suction guide hole 107 to delay the timing at which communication of the high pressure opening 103a with the opening 104 of the introducing passage 101 ends.

The piston type compressor requires some measures against prevention of bypassing of the gas between the high pressure opening 103a of the residual gas bypass groove 103 and the opening 107a of the suction guide hole 107 via the opening 104 of the introducing passage 101. In other words, in the seal area between the high pressure opening 103a of the residual gas bypass groove 103 and the opening 107a of the suction guide hole 107 at the outer surface 100a of the rotary valve 100 needs an area large enough to block the opening 104 of the introducing passage 101.

Therefore, widening the high pressure opening 103a to delay the timing at which communication of the high pressure opening 103a with the opening 104 of the introducing passage 101 ends leads to the delayed starting (delayed suction) of communication of the introducing passage 101 with the suction guide hole 107. This reduces the effect of an improvement on the volumetric efficiency brought about by collecting the residual gas.

SUMMARY OF THE INVENTION

Accordingly, it is an objective of the present invention to provide a piston type compressor capable of promptly blocking communication of the high pressure opening of a residual gas bypass groove with an opening of a communicating passage while keeping a sufficient volumetric efficiency, thereby quickly starting the suction stroke.

To achieve the above objects, the present invention provides a piston type compressor including a suction pressure zone, a discharge pressure zone, a rotary shaft, a piston type compression mechanism, a plurality of introducing passages and a cylindrical rotary valve. The internal pressure of suction pressure zone is a suction pressure. The internal pressure of the discharge pressure zone is a discharge pressure. The compression mechanism includes a plurality of cylinders and pistons. Each piston is accommodated in one of the cylinders, and defines a compression chamber in the associated cylinder. As the rotary shaft rotates, each piston draws gas from the suction pressure zone into the associated compression chamber, compresses the gas in the compression chamber, and discharges the gas to the discharge pressure zone. Each introducing passage extends from one of the compression chambers. The cylindrical rotary valve is located between the suction pressure zone and the introducing passages. The rotary valve rotates synchronously with rotation of the rotary shaft. The rotary valve has a suction communicating passage and a residual gas bypass passage. As the rotary shaft rotates, the suction communicating passage consecutively connects, through the corresponding introducing passage, the suction pressure zone with a compression chamber corresponding to a piston in the suction stroke. The residual gas bypass passage connects the introducing passage that extends from one of the compression chambers in which the discharge stroke has been

finished, or a high pressure introducing passage, with the introducing passage that extends from one of the compression chambers the pressure of which is lower than the pressure in the high pressure introducing passage. Each introducing passage has an opening that faces the outer surface of the rotary valve. The bypass passage has a high pressure opening. As the rotary valve rotates, the high pressure opening is consecutively connected with the opening of the high pressure introducing passage. A peripheral portion of the opening of each introducing passage has a first advancing area. When the high pressure opening starts being connected with the opening of the introducing passage, the first advancing area overlaps the high pressure opening. The first advancing area has a first inclined portion that is inclined relative to an axial direction and a circumferential direction of the rotary valve. A peripheral portion of the high pressure opening has a second advancing area. When the high pressure opening starts being connected with the opening of one of the introducing passages, the second advancing area overlaps the opening of the introducing passage. The second advancing area has a second inclined portion. When the high pressure opening starts being connected with the opening of one of the introducing passages, the second inclined portion extends along the first inclined portion.

The present invention also provides a piston type compressor including a suction pressure zone, a discharge pressure zone, a rotary shaft, a piston type compression mechanism, a plurality of introducing passage, and a cylindrical rotary valve. The internal pressure of the suction pressure zone is a suction pressure. The internal pressure of the discharge pressure zone is a discharge pressure. The compression mechanism includes a plurality of cylinders and pistons. Each piston is accommodated in one of the cylinders, and defines a compression chamber in the

associated cylinder. As the rotary shaft rotates, each piston draws gas from the suction pressure zone into the associated compression chamber, compresses the gas in the compression chamber, and discharges the gas to the discharge pressure zone. Each introducing passage extends from one of the compression chambers. The cylindrical rotary valve is located between the suction pressure zone and the introducing passages. The rotary valve rotates synchronously with rotation of the rotary shaft. The rotary valve has a suction communicating passage and a residual gas bypass passage. As the rotary shaft rotates, the suction communicating passage consecutively connects, through the corresponding introducing passage, the suction pressure zone with a compression chamber corresponding to a piston in the suction stroke. The residual gas bypass passage connects the introducing passage that extends from one of the compression chambers in which the discharge stroke has been finished, or a high pressure introducing passage, with the introducing passage that extends from one of the compression chambers the pressure of which is lower than the pressure in the high pressure introducing passage. Each introducing passage has an opening that faces the outer surface of the rotary valve. The bypass passage has a high pressure opening. As the rotary valve rotates, the high pressure opening is consecutively connected with the opening of the high pressure introducing passage. A peripheral portion of the opening of each introducing passage has a first trailing area. When the high pressure opening finishes being connected with the opening of the introducing passage, the high pressure opening passes over the first trailing area. The first trailing area has a first inclined portion that is inclined relative to an axial direction and a circumferential direction of the rotary valve. A peripheral portion of the high pressure opening has a second trailing area. When the high pressure opening finishes being connected with the opening of one of the introducing passages, the

second trailing area passes over the opening of the introducing passage. The second trailing area has a second inclined portion. When the high pressure opening finishes being connected with the opening of one of the introducing passages, the second inclined portion extends along the first inclined portion.

Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a cross-sectional view of a variable displacement swash plate type compressor according to a first embodiment of the present invention;

Fig. 2 is a cross-sectional view taken along line 2-2 in Fig. 1;

Fig. 3(a) is a linearly developed diagram showing the rotary motion of the rotary valve of the compressor in Fig. 1;

Fig. 3(b) is another linearly developed diagram showing the rotary motion of the rotary valve of the compressor in Fig. 1;

Fig. 4 is a developed diagram of a rotary valve according to a modified embodiment;

Fig. 5 is a developed diagram of a rotary valve according to another modified embodiment;

Fig. 6(a) is a developed diagram showing a prior art rotary valve; and

Fig. 6(b) is another developed diagram of the rotary valve in Fig. 6(a).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A piston type compressor according to one embodiment of the present invention will now be described. In this embodiment, the piston type compressor is a variable displacement swash plate type compressor for compressing a refrigerant, which used in a vehicular air-conditioning system.

As shown in Fig. 1, a variable displacement swash plate type compressor 10 has a cylinder block 11, a front housing member 12 securely connected to the front end of the cylinder block 11, and a rear housing member 13 securely connected to the rear end of the cylinder block 11 via a valve plate 13. The cylinder block 11, the front housing member 12 and the rear housing member 14 constitute the housing of the compressor 10. The leftward in Fig. 1 is the frontward of the compressor 10 and the rightward is the rearward thereof.

A crank chamber 15 is defined in an area surrounded by the cylinder block 11 and the front housing member 12. A rotary shaft 16 is placed so as to extend through the crank chamber 15 and is rotatably supported between the front housing member 12 and the cylinder block 11. The rotary shaft 16 is coupled to an engine Eg as the drive source for a vehicle and rotates with the power supplied from the engine Eg.

A lug plate 20 is fixed to the rotary shaft 16 in the crank chamber 15 in such a way as to be rotatable with the rotary shaft 16. A swash plate 21 as a driving member is retained in the crank chamber 15. The swash plate 21 is

supported on the rotary shaft 16 in such a way as to be slidable and tiltable. A hinge mechanism 22 intervenes between the lug plate 20 and the swash plate 21. Being hinged to the lug plate 20 via the hinge mechanism 22 and supported on the rotary shaft 16, therefore, the swash plate 21 is rotatable in synchronism with the lug plate 20 and the rotary shaft 16 and tiltable with respect to the rotary shaft 16 while sliding in the direction of an axis L of the rotary shaft 16.

The compressor 10 has a compression mechanism with plural (five in this embodiment) cylinders. That is, a plurality of cylinder bores 23 (only one shown in Fig. 1) are bored through the cylinder block 11 in such a way as to surround the rear end side of the rotary shaft 16 at equal angular intervals, as shown in Figs. 1 and 2. Single-headed pistons 24 are retained in the respective cylinder bores 23 in a reciprocal manner.

The front and rear openings of the cylinder bore 23 are blocked by the valve plate 13 and the piston 24. Defined in the cylinder bore 23 is a compression chamber 26 whose volume varies with the reciprocation of the piston 24 in the cylinder bore 23. Each piston 24 is engaged to the outer peripheral portion of the swash plate 21 via shoes 25. Therefore, the rotation of the swash plate 21 with the rotation of the rotary shaft 16 is converted to the reciprocal motion of the piston 24 via the shoes 25.

A suction passage 27 as a suction pressure zone and a discharge chamber 28 as a discharge pressure zone are defined in the rear housing member 14. The suction passage 27 is formed in the center portion of the rear housing member 14. The discharge chamber 28 is formed in such a way as to surround the outer surface of the suction passage 27. An external pipe, which connects to a low pressure heat exchanger

of an unillustrated external refrigerant circuit, is connected to the suction passage 27. An external pipe, which connects to a high pressure heat exchanger of the unillustrated external refrigerant circuit, is connected to the discharge chamber 28. The external refrigerant circuit and the compressor 10 constitute a refrigerant circulation circuit.

As each piston 24 moves from the top dead center to the bottom dead center, the refrigerant gas in the suction passage 27 is sucked into the compression chamber 26 via a suction valve unit 55 disposed in the cylinder block 11. As the piston 24 moves from the bottom dead center to the top dead center, the refrigerant gas sucked in the compression chamber 26 is compressed to a predetermined pressure and is discharged into the discharge chamber 28 via a discharge port 29 formed in the valve plate 13 and a discharge valve 30.

A bleed passage 31, a supply passage 32 and a control valve 33 are provided in the housing of the compressor 10. The bleed passage 31 includes an axial passage 34 formed in the axial center of the rotary shaft 16. The axial passage 34 has an inlet 34a open to the crank chamber 15 near the lug plate 20 and an outlet 34b open at the rear end of the rotary shaft 16. The supply passage 32 connects the discharge chamber 28 to the crank chamber 15. The well-known control valve 33 comprised of an electromagnetic valve is disposed in the midway of the supply passage 32.

By adjusting the degree of opening of the control valve 33, the balance between the amount of the high pressure discharge gas led into the crank chamber 15 via the supply passage 32 and the amount of the gas led out of the crank chamber 15 via the bleed passage 31 is controlled to determine the pressure in the crank chamber 15. In accordance with a change in the pressure in the crank chamber 15, the difference

between the pressure in the crank chamber 15 and the pressure in compression chamber 26 via the piston 24 is changed, thereby altering the tilt angle of the swash plate 21. As a result, the stroke of the piston 24, i.e., the displacement of the compressor 10 is adjusted.

As the pressure in the crank chamber 15 drops, for example, the tilt angle of the swash plate 21 increases and the stroke of the piston 24 increases, thereby making the displacement of the compressor 10 larger. As the pressure in the crank chamber 15 rises, on the other hand, the tilt angle of the swash plate 21 decreases and the stroke of the piston 24 decreases, thereby making the displacement of the compressor 10 smaller.

The suction valve unit 55 is discussed below.

As shown in Figs. 1 and 2, a cylindrical holding bore 17 is formed in the center portion of the cylinder block 11 and surrounded by the cylinder bores 23 in the housing of the compressor 10. A through hole 13a that connects the holding bore 17 to the suction passage 27 is bored through the valve plate 13. Plural (five in this embodiment) introducing passages 18 laid out in the cylinder block 11 at predetermined angular distances about the axis L are provided between the holding bore 17 and the individual compression chambers 26. Each introducing passage 18 connects the holding bore 17 to the associated compression chamber 26.

A bottomed cylindrical rotary valve 35 having a bottom frontward is rotatably retained in the holding bore 17. An inner surface 17a of the holding bore 17 is slidably in contact with an outer surface 35b of the rotary valve 35. A communicating hole 35c extending along the direction of the axis L is bored through at the front side of the rotary valve

35. A suction chamber 36 that is the cylindrical space in the rotary valve 35 communicates with the axial passage 34 (outlet 34b) of the rotary shaft 16 via the communicating hole 35c. The communicating hole 35c is a part of the bleed passage 31 and the suction chamber 36 is the suction pressure zone to which the bleed passage 31 is connected. The bleed passage 31 connects the crank chamber 15 to the suction chamber 36.

The rotary valve 35 has a small-diameter portion 35a that is smaller in diameter than the other portion. An attachment hole 16a is provided at the rear end portion of the rotary shaft 16. The small-diameter portion 35a of the rotary valve 35 is securely fitted with pressure in the attachment hole 16a of the rotary shaft 16. Accordingly, the rotary shaft 16 and the rotary valve 35 are laid out on the same axis L and integrated, so that the rotary valve 35 rotates in synchronism with the rotation of the rotary shaft 16 or the reciprocation of the piston 24. The outer surface 35b of the rotary valve 35 and the inner surface 17a of the holding bore 17 constitute a slide bearing surface that supports the rear end portion of the rotary shaft 16 in a rotatable manner.

The suction chamber 36 of the rotary valve 35 communicates with the suction passage 27 via the through hole 13a of the valve plate 13. A suction guide hole 37 that is normally connected to the suction chamber 36 is formed in a given circumferential zone in the wall of the rotary valve 35. The suction guide hole 37 serves as a suction communicating passage that sequentially connects the suction chamber 36 as the suction pressure zone to the introducing passages 18 extending from the individual compression chambers 26 in synchronism with the rotation of the rotary valve 35.

In the case where the piston 24 moves from the top dead center to the bottom dead center (suction stroke), the suction

guide hole 37 communicates with the introducing passage 18 of the cylinder block 11. The refrigerant gas in the suction passage 27 is sucked into the compression chamber 26, passing the suction chamber 36 of the rotary valve 35, the suction guide hole 37 and the introducing passage 18 in the named order.

When the piston 24 reaches the bottom dead center, the suction guide hole 37 is completely deviated circumferentially from the introducing passage 18, so that suction of the refrigerant gas into the compression chamber 26 from the suction chamber 36 is stopped. As the piston 24 moves toward the top dead center (compression/discharge stroke), the seal area of the outer surface 35b of the rotary valve 35 keeps the space between the introducing passage 18 and the suction chamber 36 blocked, so that the compression of the refrigerant gas and the discharge of the compressed gas into the discharge chamber 28 are not interfered.

The following discusses the residual gas bypass structure.

Figs. 3(a) and 3(b) illustrate a state where the rotary motion of the rotary valve 35 is developed linearly and the rotation of the rotary valve 35 about the axis L of the rotary valve 35 is transformed to the leftward movement. A residual gas bypass groove 41 as residual gas bypass passage is formed in the seal area at the outer surface 35b of the rotary valve 35.

The residual gas bypass groove 41 includes a high pressure groove 42 as a high pressure opening extending along the axis L of the rotary valve 35, a low pressure groove 43 likewise extending along the axis L and a communicating groove 44 that extends along the circumferential direction (lateral

direction in the diagrams) of the rotary valve 35 and connects the front ends of both grooves 42 and 43. The residual gas bypass groove 41 connects a high pressure introducing passage 18A among the plural introducing passages 18 that communicates with the high pressure compression chamber 26 in which the discharge stroke has been finished with a low pressure introducing passage 18B that extends from the compression chamber 26 the pressure of which is lower than the pressure in the compression chamber 26 in which the discharge stroke has been finished (the high pressure introducing passage 18A).

The high pressure groove 42 is located in the outer surface 35b of the rotary valve 35 at the seal area facing the high pressure introducing passage 18A. The low pressure groove 43 is located in the outer surface 35b of the rotary valve 35 at the seal area facing the low pressure introducing passage 18B. The timing at which communication of the low pressure groove 43 with the low pressure introducing passage 18B starts is set slightly earlier than the timing at which communication of the high pressure groove 42 with the high pressure introducing passage 18A starts.

The refrigerant gas (residual gas) remaining undischarged in the compression chamber 26 immediately after the end of the discharge stroke is bypassed (collected into) to the low pressure compression chamber 26 immediately after the end of the suction stroke, passing the high pressure introducing passage 18A, the high pressure groove 42, the communicating groove 44, the low pressure groove 43 and the low pressure introducing passage 18B in order. This makes re-expansion of the residual gas bypass in the suction stroke of the compression chamber 26 less, so that the refrigerant gas in the suction chamber 36 is reliably led into the compression chamber 26, thereby improving the volumetric efficiency of the compressor 10.

As indicated by the two-dot chain lines in Figs. 3(a) and 3(b), each introducing passage 18 provided in the cylinder block 11 has an opening 51 facing the outer surface 35b of the rotary valve 35. For the sake of convenience of ensure the strength of the cylinder block 11 or some other reasons, a peripheral portion 52 of the opening 51 of each introducing passage 18 has curved portions 52b curved in other directions than the radially outward direction of the rotary valve 35. That is, as seen from the developed view of the inner surface 17a of the holding bore 17, the peripheral portion 52 of the opening 51 includes a linear portion 52a of a given width extending along the axis L and the curved portions 52b formed at both ends of the linear portion 52a and having an approximately semicircular shape. The curved portion 52b functions as a first advanced area.

The right-hand straight part of the linear portion 52a of the peripheral portion 52 in the diagrams is a advancing area 52a-1 and the left-hand straight part of the linear portion 52a is a trailing area 52a-2. In the curved portion 52b positioned closer to the communicating groove 44, an approximately right quarter circle portion in the diagrams is an advancing area 52b-1 and an approximately left quarter circle portion in the diagrams is a trailing area 52b-2.

In this embodiment, a part of the advancing area 52a-1 of the linear portion 52a and the advancing area 52b-1 of the curved portion 52b constitute the "first advancing area" in the peripheral portion 52 of the opening 51 of the introducing passage 18. In this embodiment, a part of the trailing area 52a-2 of the linear portion 52a and the trailing area 52b-2 of the curved portion 52b constitute the "first trailing area" in the peripheral portion 52 of the opening 51 of the introducing passage 18.

The advancing area 52b-1 and the trailing area 52b-2 of the curved portion 52b extend in the circumferential direction and the direction of the axis L of the rotary valve 35, respectively. In this embodiment, the advancing area 52b-1 and trailing area 52b-2 of the curved portion 52b are respectively equivalent to inclined portions.

As seen from the developed view of the outer surface 35b of the rotary valve 35, the high pressure groove 42 of the residual gas bypass groove 41 has a proximal portion 42a of a given width extending rearward in the direction of the axis L from the communicating groove 44 and a distal portion 42b extending rearward in the direction of the axis L from the proximal portion 42a and having a crest-like shape with the proximal portion 42a as the foot side.

With the distal portion 42b, the high pressure groove 42 can communicate with the opening 51 of the introducing passage 18. A peripheral portion 45 of the distal portion 42b in the high pressure groove 42 includes a curved portion 45a on that side of the proximal portion 42a and a linear portion 45b of a given width on the distal end side.

In the peripheral portion 45 of the distal portion 42b of the high pressure groove 42, that straight part of the linear portion 45b that is far from an opening 37a of the suction guide hole 37 is an advancing area 45b-1 and that straight part of the linear portion 45b that is close to the opening 37a of the suction guide hole 37 is a trailing area 45b-2. In the peripheral portion 45 of the distal portion 42b of the high pressure groove 42, an approximately quarter circle portion on the far side from the opening 37a of the suction guide hole 37 is a advancing area 45a-1 and an approximately left quarter circle portion on the side close to the opening

37a of the suction guide hole 37 is a trailing area 45a-2.

In this embodiment, the advancing area 45b-1 of the linear portion 45b and the advancing area 45a-1 of the curved portion 45a constitute the "second advancing area" in the peripheral portion 45 of the high pressure groove 42. In this embodiment, the trailing area 45b-2 of the linear portion 45b and the trailing area 45a-2 of the curved portion 45a constitute the "second trailing area" in the peripheral portion 45 of the high pressure groove 42.

The individual areas 45a-1 and 45a-2 of the curved portion 45a are curved inward of the high pressure groove 42. The figure of the advancing area 45a-1 is congruous with the figure of the advancing area 52b-1 of the curved portion 52b of the opening 51. The figure of the trailing area 45a-2 is congruous with the figure of the trailing area 52b-2 of the curved portion 52b of the peripheral portion 52.

As shown in Fig. 3(a), the entire advancing area 45b-1 of the linear portion 45b of the peripheral portion 45 of the distal portion 42b in the high pressure groove 42 overlaps a part of the advancing area 52a-1 of the linear portion 52a of the peripheral portion 52 at the time communication of the peripheral portion 45 with the opening 51 of the introducing passage 18A starts. Further, the entire advancing area 45a-1 of the curved portion 45a of the peripheral portion 45 of the distal portion 42b in the high pressure groove 42 overlaps the advancing area 52b-1 of the curved portion 52b of the peripheral portion 52 at the time communication of the peripheral portion 45 with the opening 51 of the introducing passage 18A starts.

That is, in this embodiment, the advancing area 45a-1 of the curved portion 45a at the peripheral portion 45 of the

high pressure groove 42 can be grasped as a "inclined portion that can extend along the inclined portion of the peripheral portion at the opening of the communicating passage at the beginning of communication with the opening of the communicating passage".

As shown in Fig. 3(b), the entire trailing area 45b-2 of the linear portion 45b of the peripheral portion 45 of the distal portion 42b in the high pressure groove 42 overlaps a part of the trailing area 52a-2 of the linear portion 52a of the peripheral portion 52 at the time communication of the peripheral portion 45 with the opening 51 of the introducing passage 18A ends. Further, the entire trailing area 45a-2 of the curved portion 45a of the peripheral portion 45 of the distal portion 42b in the high pressure groove 42 overlaps the trailing area 52b-2 of the curved portion 52b of the peripheral portion 52 at the time communication of the peripheral portion 45 with the opening 51 of the introducing passage 18A ends.

That is, in this embodiment, the trailing area 45a-2 of the curved portion 45a at the peripheral portion 45 of the high pressure groove 42 can be grasped as a "inclined portion that can extend along the inclined portion of the peripheral portion at the opening of the communicating passage at the end of communication with the opening of the communicating passage".

The embodiment with the above-described structure has the following advantages.

An inclined portion (advancing area 45a-1) that can extend along the inclined portion (advancing area 52b-1) of the peripheral portion 52 at the beginning of communication with the opening 51 of the high pressure introducing passage

18A is formed in the advancing area 45a-1, 45b-1 of the peripheral portion 45 in the high pressure groove 42.

When communication with the high pressure introducing passage 18A starts, as indicated by the two-dot chain line in Fig. 3(a), the advancing area 45a-1 of the curved portion 45a at the opening's peripheral portion 45 of the high pressure groove 42 quickly passes through the advancing area 52b-1 of the curved portion 52b of the peripheral portion 52. Therefore, the opening area (overlapping area) with respect to the opening 51 of the introducing passage 18A is increased rapidly.

Consequently, even with the quickened timing of ending communication with the opening 51 of the high pressure introducing passage 18A and the high pressure groove 42, the residual gas in the compression chamber 26 is reliably bypassed, and eventually the timing of starting communication of the high pressure introducing passage 18A with the suction guide hole 37 can be advanced. In other words, this embodiment can effectively use the advancing area 52b-1, 52b-2 of the curved portion 52b in the opening 51 of the high pressure introducing passage 18A as the portion where the residual gas passes immediately after the beginning of the communication with the high pressure groove 42.

Particularly, this embodiment is designed in such a way that the entire advancing area 45a-1 of the high pressure groove 42 overlaps the advancing area 52b-1 of the high pressure introducing passage 18A at the time communication of the high pressure groove 42 with the opening 51 of the introducing passage 18A starts. Therefore, the aforementioned advantage works more effectively.

An inclined portion (trailing area 45a-2) that can extend

along the inclined portion (trailing area 52b-2) of the peripheral portion 52 at the end of communication with the opening 51 of the introducing passage 18A is formed in the trailing area 45a-2, 45b-2 of the peripheral portion 45 in the high pressure groove 42.

Therefore, as shown in Fig. 3(b), the trailing area 45a-2 of the curved portion 45a at the opening's peripheral portion 45 of the high pressure groove 42 does not suddenly pass through the trailing area 52b-2 of the curved portion 52b of the peripheral portion 52 until the end of the communication of the high pressure groove 42 with the opening 51 of the high pressure introducing passage 18A. As indicated by the two-dot chain line in Fig. 3B, therefore, the opening area with respect to the opening 51 of the introducing passage 18A in the high pressure groove 42 can be kept greatly until immediately before the end of the communication of the high pressure groove 42 with the opening 51 of the high pressure introducing passage 18A.

As a result, even with the quickened timing of ending communication of the high pressure groove 42 with the opening 51 of the high pressure introducing passage 18A, the residual gas in the compression chamber 26 is reliably bypassed, and eventually the timing of starting communication of the high pressure introducing passage 18A with the suction guide hole 37 of the introducing passage 18A can be advanced. In other words, this embodiment effectively uses the advancing area 52b-1, 52b-2 of the curved portion 52b in the opening 51 of the high pressure introducing passage 18A as the portion where the residual gas passes until immediately before the end of the communication with the high pressure groove 42.

Particularly, this embodiment is designed in such a way that the entire trailing area 45a-2 of the high pressure

groove 42 overlaps the trailing area 52b-2 of the high pressure introducing passage 18A at the time communication of the high pressure groove 42 with the opening 51 of the introducing passage 18 ends. Therefore, the aforementioned advantage works more effectively.

It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the invention may be embodied in the following forms.

As shown in Fig. 4, the peripheral portion 45 of the high pressure groove 42 may be constructed in such a way that only the advancing area 45a-1 of the curved portion 45a extends along the advancing area 52b-1 of the curved portions 52b of the peripheral portion 52 of the high pressure introducing passage 18A at the beginning of the communication of the high pressure groove 42 with the opening 51 of the high pressure introducing passage 18A. In this case, the trailing area 45b-2 of the linear portion 45b extends linearly to the communicating groove 44.

This embodiment has advantages similar to those of the embodiment in Figs. 1 to 3(b).

As shown in Fig. 5, the peripheral portion 45 of the high pressure groove 42 may be constructed in such a way that only the trailing area 45a-2 of the curved portion 45a extends along the trailing area 52b-2 of the curved portions 52b of the peripheral portion 52 of the high pressure introducing passage 18A at the end of the communication of the high pressure groove 42 with the opening 51 of the high pressure introducing passage 18A. In this case, the advancing area 45b-1 of the linear portion 45b extends linearly to the

communicating groove 44. This embodiment also has advantages similar to those of the embodiment in Figs. 1 to 3(b).

In the embodiments in Figs. 1 to 3(b) and Fig. 4, extension of the advancing area 45a-1 of the high pressure groove 42 along the advancing area 52b-1 of the high pressure introducing passage 18A is not limited to the entire advancing area 45a-1 overlapping the advancing area 52b-1.

That is, the advancing area 45a-1 of the high pressure groove 42 and the advancing area 52b-1 of the high pressure introducing passage 18A may be laid out slightly deviated from each other along the direction of the axis L. Alternatively, in the embodiments in Figs. 1 to 3(b) and Fig. 4, for example, the degree of curvature of the advancing area 45a-1 of the high pressure groove 42 may be made slightly different from the degree of curvature of the advancing area 52b-1 of the high pressure introducing passage 18A.

In the embodiments in Figs. 1 to 3(b) and Fig. 5, extension of the trailing area 45a-2 of the high pressure groove 42 along the trailing area 52b-2 of the high pressure introducing passage 18A is not limited to the entire trailing area 45a-2 overlapping the trailing area 52b-2.

That is, the trailing area 45a-2 of the high pressure groove 42 and the trailing area 52b-2 of the high pressure introducing passage 18A may be laid out slightly deviated from each other along the direction of the axis L. Alternatively, in the embodiments (Figs. 1 to 3(b) and Fig. 5), for example, the degree of curvature of the trailing area 45a-2 of the high pressure groove 42 may be made slightly different from the degree of curvature of the trailing area 52b-2 of the high pressure introducing passage 18A.

In the embodiments in Figs. 1 to 3(b) and Fig. 5, the linear portion 45b (advancing area 45b-1 and trailing area 45b-2) may be omitted from the high pressure groove 42.

In the embodiments in Figs. 1 to 5, as seen from the developed view of the inner surface 17a of the holding bore 17, the peripheral portion 52 of the introducing passage 18 has the curved portions 52b (inclined portions 52b-1, 52b-2) curved in the direction of the axis L. However, the shapes of the inclined portions are not limited to the curved shape in the state where the holding bore 17 is developed. That is, the inclined portions may have a linear shape in the state where the holding bore 17 is developed, as long as the condition that the inclined portions extend in the circumferential direction of the rotary valve 35 and the direction of the axis thereof is satisfied. In this case, the advancing areas 45a-1, 45a-2 of the high pressure groove 42 are designed to have a linear shape in the state where the outer surface 35b of the rotary valve 35 is developed.

The invention may be adapted to a wobble type variable displacement compressor.

The invention may be adapted to a double-headed piston type compressor.

The invention may be adapted to a piston type compressor 10 that uses a wave cam, in place of the swash plate 21, as a driving member.

The present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.